DOCUMENT RESUME

ED 050 423 24 CG 006 430

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TITLE Same- and Mixed-Modality Presentation in Continuous Recognition Memory. Report from the Project on Variables and Processes in Cognitive Learning.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY Office of Education (DHEW), Washington, D.C.
REPORT NO TR-156
BUREAU NO BR-5-0216
PUB DATE Mar 71
CONTRACT OEC-5-10-154
NOTE 12p.

EDRS PRICE EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS Auditory Perception, *Cognitive Processes, Memorizing, *Memory, *Recognition, *Retention, *Verbal Learning, Visual Stimuli

ABSTRACT

Recent theories of verbal memory have hypothesized that memory for a stimulus is not represented by a unitary memory trace, but rather by a coding on several attributes of the event. The present experiment tested the differential forgetting hypothesis in a unique way. Words were presented either visually (V) or auditorally (A) in a continuous recognition memory task. Each word occurred twice, with equal numbers of item pairs in each of the four possible modality combinations (A-A, V-V, A-V, and V-A). The first and second occurrence of a word were separated by 12, 24, 48, and 96 intervening items. Two lists, common and rare nouns, were used. Averaging data from the two lists, a greater number of misses occurred on mixed-modality than same-modality pairs at the first three intervals. At the 96-item interval mixed-modality was superior to same-modality presentation for the rare list only. The results are discussed in terms of Underwood's multi-attribute theory of memory. (Author)

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SAME- AND MIXED-MODALITY PRESENTATION IN CONTINOUS RECOGNITION MEMORY

WISCONSIN RESEARCH AND DEVELOPMENT

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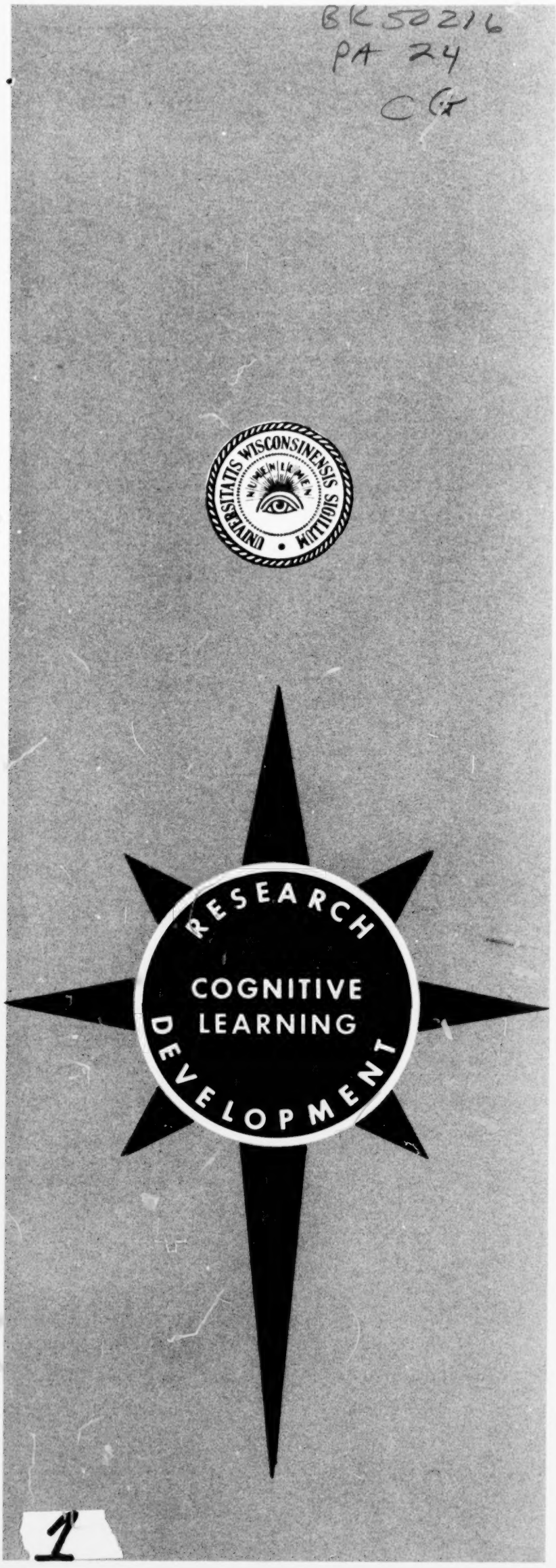

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ED050423

Technical Report No. 156

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By Peter Wolff

Report from the Project on Variables and
Processes in Cognitive Learning

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March 1971

Published by the Wisconsin Research and Development Center for Cognitive Learning, supported in part as a research and development center by funds from the United States Office of Education, Department of Health, Education, and Welfare. The opinions expressed herein do not necessarily reflect the position or policy of the Office of Education and no official endorsement by the Office of Education should be inferred.

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STATEMENT OF FOCUS

The Wisconsin Research and Development Center for Cognitive Learning focuses on contributing to a better understanding of cognitive learning by children and youth and to the improvement of related educational practices. The strategy for research and development is comprehensive. It includes basic research to generate new knowledge about the conditions and processes of learning and about the processes of instruction, and the subsequent development of research-based instructional materials, many of which are designed for use by teachers and others for use by students. These materials are tested and refined in school settings. Throughout these operations behavioral scientists, curriculum experts, academic scholars, and school people interact, insuring that the results of Center activities are based soundly on knowledge of subject matter and cognitive learning and that they are applied to the improvement of educational practice.

This Technical Report is from the Project on Variables and Processes in Cognitive Learning in Program 1, Conditions and Processes of Learning. General objectives of the Program are to generate knowledge and develop general taxonomies, models, or theories of cognitive learning, and to utilize the knowledge in the development of curriculum materials and procedures. Contributing to these Program objectives, this project has these objectives: to ascertain the important variables in cognitive learning and to apply relevant knowledge to the development of instructional materials and to the programming of instruction for individual students; to clarify the basic processes and abilities involved in concept learning; and to develop a system of individually guided motivation for use in the elementary school.

GPO 822-323-2

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I
INTRODUCTION

Recent theories of verbal memory have hypothesized that memory for a stimulus is not represented by a unitary memory trace, but rather by a coding on several attributes of the event (Bower, 1967; Underwood, 1969). The inventory of attributes proposed by Underwood (1969) can be divided into those specific to the stimulus words themselves, and those which refer to supra-stimulus properties, such as temporal or spatial position or generic features of the stimuli as a group. Stimulus-specific properties can in turn be divided into physical attributes of the stimulus, such as acoustic or orthographic features, and associative, or semantic, attributes.

Underwood (1969) points out that different attributes may be characterized by different acquisitions and forgetting functions, but cites the paucity of research related to this question. Broadbent's (1958) information processing model proposes that information enters first into a sensory store and then into a perceptual store. The sensory store is pre-categorical and transitory, while the perceptual store is post-interpretive, larger, and more permanent. If the sensory store is considered to be specific to physical information and the perceptual store to meaning or semantic information, then Broadbent's theory would suggest that physical information should become unavailable before semantic information.

Consistent with this hypothesis, Baddeley and Dale (1966) have reported that acoustically confusable alternatives inhibit correct recognition of material in short-term store, but not in long-term store. The reverse is true when semantically confusable alternatives are used (Baddeley, 1966). Ghatala (1970) has obtained similar findings with grade school children. In a recognition memory task children who were tested immediately chose acoustically confusable foils as often as semantically confusable ones. After 48 hours, the incidence of acoustic confusions was considerably reduced relative to semantic confusions.

The present experiment tested the differential forgetting hypothesis in a different way. It was assumed that if acoustic and orthographic attributes are indeed different and at least partially independent, then in a continuous recognition task in which words are presented either visually or auditorally, cross-modality matches should be more difficult than same-modality matches. Furthermore, if physical attributes are lost before semantic attributes, this difference in difficulty should decrease as the number of intervening items between presentation and test increases.

It was also hypothesized that physical properties would be relatively more relevant for correct recognition of rare words than common words since rare words should arouse a more limited part of the semantic system.

II
METHOD

SUBJECTS

Twenty male adults, employes of the Wisconsin Research and Development Center, served individually in two sessions separated by at least one day.

MATERIALS AND APPARATUS

Two lists of two-syllable nouns were generated from the Thorndike-Lorge (1944) word count. One list was composed of common words, occurring at least 50 times per million. The other was made up of rare words occurring less than four times per million. The words comprised almost the entire population of words conforming to the above restrictions.

Each list was 413 items long, with 160 item pairs, or 320 items, actually used in the analysis. The remaining items were either primers used at the beginning of the word list to build up material in store, or else filler items used at the end of the list. The first and second occurrence of an item pair was separated by either 12, 24, 48, or 96 intervening items, with 40-item pairs tested at each interval. For 20-item pairs at each interval both occurrences of the pair were presented in the same modality—auditory-auditory (A-A) for 10 item pairs and visual-visual (V-V) for the remaining 10 pairs. For the remaining 20 item pairs, the two occurrences of the item were presented in different modalities—10 A-V pairs and 10 V- A pairs. Words were ordered randomly in the lists, except that an attempt was made to separate conceptually or acoustically similar words by at least one item to minimize the use of clustering strategies.

The lists were typed on vellum memory drum tape and presented on a Stowe memory drum. When a word was to be presented visually; it was typed on the tape in Elite capital letters. When a word was to be presented auditorally, a blank space was left on the tape.

Subjects wore Koss earphones which were connected to the output of one channel of a two-channel Ampex tape recorder. The input to this channel was a microphone used by E, a male, to present the auditory stimuli. A second microphone was worn by S, and delivered his responses to the second channel of the recorder. Thus, one channel of the recorder was used to record the words presented auditorally and to present these words to S over the earphones. The second channel recorded S's responses.

PROCEDURE

The S was seated on one side of a desk which had been cut to allow the excess drum tape to pass through the desk top and into a box. The E sat on the opposite side of the desk separated from S by a wooden partition. After the microphone and earphones were placed on S, the procedure was explained.

During presentation of the list, E followed a script which indicated the modality of each stimulus. At each turn of the memory drum a word either appeared in the window of the drum or was read from the script by E. A new word was presented every 2 seconds.

Each S received both stimulus lists. Half of the Ss saw the common list in the first session and the rare list in the second session. For the remaining half, the order was reversed. During scoring of the tapes, S's final response before the presentation of the next item was considered as the valid response.

III
RESULTS

Error frequencies comprised the data for analysis. The two possible types of errors, misses and false-alarms, were analyzed separately.

MISSES

Misses were analyzed in an analysis of variance with modality of first stimulus, modality of second stimulus, list (common or rare), and interval (12, 24, 48, or 96 intervening items) as within-subject factors. Order of presentation of the two lists was a between-subject factor. In order to correct for unequal variances at the different intervals the data were transformed by applying the formula log (N + 1) to each error score.

As expected, more misses occurred as the number of intervening items increased, $F(3, 56) = 57.40$; $p < .001$. Performance on the two lists did not differ ($F = 1.03$). There was also no effect of modality of either the first or second stimulus. There was, however, an interaction between list and order of presentation, $F(1, 18) = 9.5$ < .01, reflecting the fact that fewer misses were made on the common list when it was presented in the first session than in the second session.

Of primary interest in the present study is the difference between same and mixed modality presentation. As predicted, this factor, represented by the interaction of modality of first stimulus and modality of second stimulus, was significant, with $F(1, 18) = 6.03$, $p < .025$. This difference interacted with the interval between first and second occurrence of the stimulus, $F(3, 54) = 3.70$; $p < .025$. The interaction is shown in Figure 1. At the first three intervals more errors were made on mixed-modality than same-modality pairs. At the largest interval the order is reversed, with a somewhat greater number of errors being made on same-modality pairs.

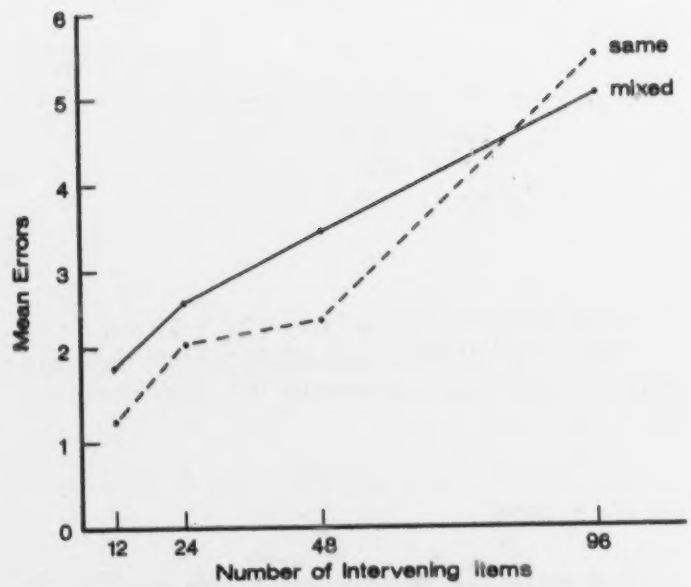

Figure 1. Number of Misses for Same- and Mixed-Modality Pairs as a Function of Number of Intervening Items Between First and Second Presentation

The effects of modality and interval were somewhat different for the common and rare words, as expressed by a significant quadruple interaction of the four within-subject variables, $F(3, 54) = 3.73$; $p < .025$. Table 1 shows the mean number of same- and mixed-modality errors and associated t values at each interval for the two lists. For the rare words the superiority of same-modality pairs is significant at the three shorter intervals. At the longest interval there is a reversal, significant at the .05 level by a two-tailed test. For the common list, with the exception of the second interval, there seems to be a moderate superiority of same-modality presentation throughout. If, however, one considers the percent of total errors which are mixed-modality errors, thus

Table 1

Mean Number of Misses on Same- and
Mixed-Modality Pairs for Common and Rare Word Lists

		Interval			
		12	24	48	96
Common	Same	1.20	2.40	2.35	4.85
	Mixed	1.65	2.40	3.00	5.45
	t	1.339*	0.000	1.290	1.015
Rare	Same	1.30	1.90	2.50	6.20
	Mixed	2.10	2.85	3.95	4.65
	t	2.430***	2.298***	2.549***	-2.210**

*p < .10
**p < .05
***p < .025

for correcting for scale, there is a slight decrease in the different-modality errors from the third to the fourth intervals (56.07% versus 52.91%).

FALSE ALARMS

Over twice as many false-alarms were given to common words as to rare words, $F(1, 18) = 26.80$; $p < .001$. A significant interaction between list and order, $F(1, 18) = 5.58$; $p < .05$ reflects the fact that fewer false-alarms were given on the common list when it was presented second than when presented first. Together with the interaction for misses reported above this finding implies that Ss' adopted a more conservative criterion for an "old" response on the common list when it occurred in the second session. A much smaller criterion shift in the opposite direction was observed for rare words.

The triple interaction of list, modality, and order was also significant, $F(1, 18) = 8.64$; $p < .01$. In Session 1, regardless of which list was presented, more false-alarms were given to auditory stimuli than to visual. For Session 2 the situation was reversed, with more false-alarms given to visual stimuli. Roughly compensatory results were found for misses, again suggesting a criterion shift from first to second session.

IV
DISCUSSION

A multi-attribute theory of memory would predict that to the degree that modality-specific physical features are used in the recognition process, recognition for same-modality pairs should be facilitated relative to mixed-modality pairs. This result was found in the present study. Modality itself was not a significant factor in the analyses of either misses or false-alarms.

The hypothesis that the modality effect would diminish as the number of intervening items increased was not supported in a clear-cut way because of the different patterns of misses made on the high- and low-frequency lists. The modality effect was relatively small for the high-frequency words and did not change with interval. The superiority of same-modality presentation was more marked for low frequency, than high-frequency, words at the first three intervals. This was predicted on the assumption that at the fast presentation rate used the rare words would arouse a more limited part of the meaning structure, making physical features relatively more salient for their recognition. But the significant superiority of mixed-modality presentation at the 96-item interval cannot be explained merely by the decay of physical feature information. This result is probably not an artifact of the words used at that interval since it is found in the comparison of both A-A with A-V and V-V with V-A items. It was also replicated with a different sample.

One possibility is that after 96 items of rapidly presented words a large amount of interference is present at the physical feature level. A test item in the same modality as the original item may be judged new on the basis of an inadequate test on physical features. A test item on a different modality may, on the other hand, undergo a more immediate test at the semantic level. For the rare words, which are hypothesized to arouse a more limited part of the meaning structure than the common words, relatively less interference should be present at the semantic level than at the physical feature level after 96 intervening items, resulting in the superiority of mixed-modality presentation at that level. The finding of fewer false-alarms for rare words, suggesting that less semantic interference accumulates in this list than in the list of common words, provides same support for this admittedly post hoc explanation.

REFERENCES

Baddeley, A. D. Short-term memory for word sequences as a function of acoustic, semantic, and formal similarity. Quarterly Journal of Experimental Psychology, 1966, 18, 362-365.

Baddeley, A. D. & Dale, H. C. The effect of semantic similarity on retroactive interference in long- and short-term memory. Journal of Verbal Learning and Verbal Behavior, 1966, 5, 417-420.

Bower, G. A multicomponent theory of the memory trace. In K. W. Spence & J. T. Spence (Eds.), The psychology of learning and motivation, Vol. 1. New York: Academic Press, 1967.

Broadbent, D. E. Perception and communication. New York: Pergamon Press, 1958.

Ghatala, E. S. Encoding verbal units in memory: Changes in memory attributes as a function of age, instructions, and retention interval. Technical Report from the Wisconsin Research and Development Center for Cognitive Learning, June, 1970, No. 134.

Thorndike, E. L. & Lorge, I. The teacher's word book of 30,000 words. New York: Columbia University, 1944.

Underwood, B. J. Attributes of memory. Psychological Review, 1969, 76, 559-573.

GPO 822-323-3